ANOTHER USEFUL MULTIBAND ANTENNA — THE DELTA LOOP

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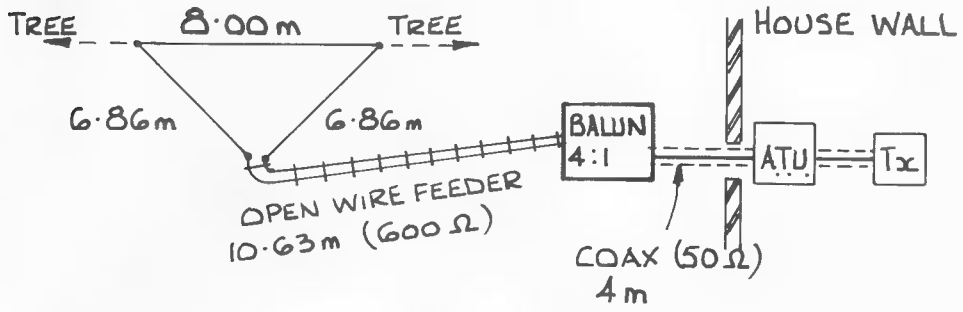
Courtesy QUA (Hornsby & Districts ARC), January '83

The original idea for this antenna came from RadCom a year or two ago. Having reached Mark 6 in my search for a compact versatile and effective HF antenna, I tested and developed this antenna and have used it happily for about two years now.



My restrictions include the need for an unbalanced coaxial feed through a hole in the wall of the house and a maximum length of the antenna top of about 8 m. The open-wire feeder is home-brew using perspex spacers about 10 cm long. The balun is a commercial type. Tests show that the balun is reasonable from 3.5 to 21 MHz, but drops off at 28 MHz in that the transformed feed impedance is rather lower than it should be. The feeder and antenna are made from 16 SWG hard-drawn copper wire.

The resonant length of a full-wave loop in metres is given by:

$$L = \frac{306.3}{f(MHz)} = 21.72 \text{ m at } 14.10 \text{ MHz.} \quad \text{(Ref 1)}$$

This is slightly longer than one wavelength which is $\frac{299.8}{f(MHz)} = 21.26$ m.

The exact lengths of each side of the loop are not critical. I use 8 m for the top and 6.86 m for each side. The open-wire feeder is one half-wavelength long at 14.1 MHz which is 10.63 m.

On 14.1 MHz the feed impedance at the base of the loop is expected to be about 100 ohms (Ref 1). After one half wavelength of open feeder having an SWR of 6:1 but negligible loss the balun transforms this to ¼ x 100 = 25 ohms. A tolerable match with an expected SWR of 2:1 to a short length of 50 ohm coax. The ATU can well cope with this. The measured SWR on the antenna side of the ATU is 1.7:1 but on the transmitter side 1:1.

On 7.05 MHz the loop is only a half-wavelength round and the impedance is high, maybe 2000 ohms, but the open feeder of one quarter-wavelength transforms this down to a low-impedance feed at the balun. Alternatively the entire loop plus feeder perimeter is 40 m or one wavelength giving a low-impedance feed. Because the loop is smaller in relation to the wavelength at 7 MHz than at 14 MHz the feed impedance will be lower, say 25 ohms. The balun transforms this down to ¼ x 25 = 6.25 ohms. A rather poor match to the 50 ohm coax with an expected SWR of 8:1 but the losses in such a short length are still very small. The measured SWR on the antenna-side of the ATU is actually around 10:1. SWR meters are not at all accurate at such high values. But the ATU copes easily to present 50 ohms to the transmitter.

Again treating the whole 40 m perimeter of the loop plus feeder this total length is 3 wavelengths on 21 MHz and 4 wavelengths on 28 MHz giving low-impedance feeds on both bands at the balun. Probably around 200 ohms and 400 ohms respectively. The balun brings these down to 50 ohms and 100 ohms with expected SWRs of 1:1 and 2:1 respectively on the short length of coax. Measured values 1.3:1 and 2.3:1. Again the ATU fixes these to exactly 50 ohms for the transmitter.

Finally on 3.5 MHz the loop plus feeder perimeter is one half wavelength, and the balun sees a very high impedance, probably about 4000 ohms. Even when this is reduced by the balun to ¼ x 4000 = 1000 ohms this impedance is not very satisfactory for the coax with an SWR of 20:1. This difficulty could be solved by opening a link in the centre of the antenna top which would restore low feed impedance but this is not physically convenient nor would it radiate well. In fact, though the balun has too few turns for such a high impedance at 3.5 MHz and too low a voltage rating to be used at a low-current high-voltage point in the feeder it copes quite well. However the feed impedance at the ATU is still high at maybe 500 ohms and complex (capacitive). The ATU cannot cope alone with this at any settings but with the addition of a simple inductive stub to tune out the capacitance it works fine. This stub consists of a shorted length of 10 m of 50 ohm coax connected directly across the output of the ATU only on the 3.5 MHz band using a coaxial T-connector.

Another alternative frequently suggested for this kind of situation is to tie the two feeder wires together and feed the whole system as a single wire against earth. I have tried numerous antennas fed against earth and found them all very unsatisfactory especially on transmit unless a very good earth system can be devised. I have been unable to make a sufficiently good earth in my location with the result that most of the transmitter output power went into heating the garden. Balanced antenna systems are much superior or you might try the use of counterpoises or equivalent arrangements not fed against earth.

How does it work out in practice? Of course the system will not perform as well as a beam although it does have some directional characteristics. It seems to work well on all bands and perhaps even on 10 MHz. I have no trouble working most stations even into Europe on 21 and 28 MHz and with a little more trouble 14 MHz. The whole antenna incidentally is surrounded by tall trees and high buildings though the take-off west and north is reasonable.

As to its directional characteristics, on 14 MHz it is simply the driven element of a quad antenna, radiating broadside horizontally polarised. On 28 MHz theory suggests that it should radiate best off the ends with vertical polarisation. On 21 MHz off the ends with vertical polarisation and broadside with horizontal polarisation. On 10, 7 and 3.5 MHz it should radiate mostly broadside (horizontal) but a little off the ends (vertical). These calculations were based on the simpler-to-analyse square loop. When I can find time to reprogramme the problem for a triangular loop, I expect to get essentially similar results.

REFERENCES

1 ARRL Antenna Book.

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